C3.2.7 Substructures

C3.2.7.1 Skew

C3.2.7.2 Abutments

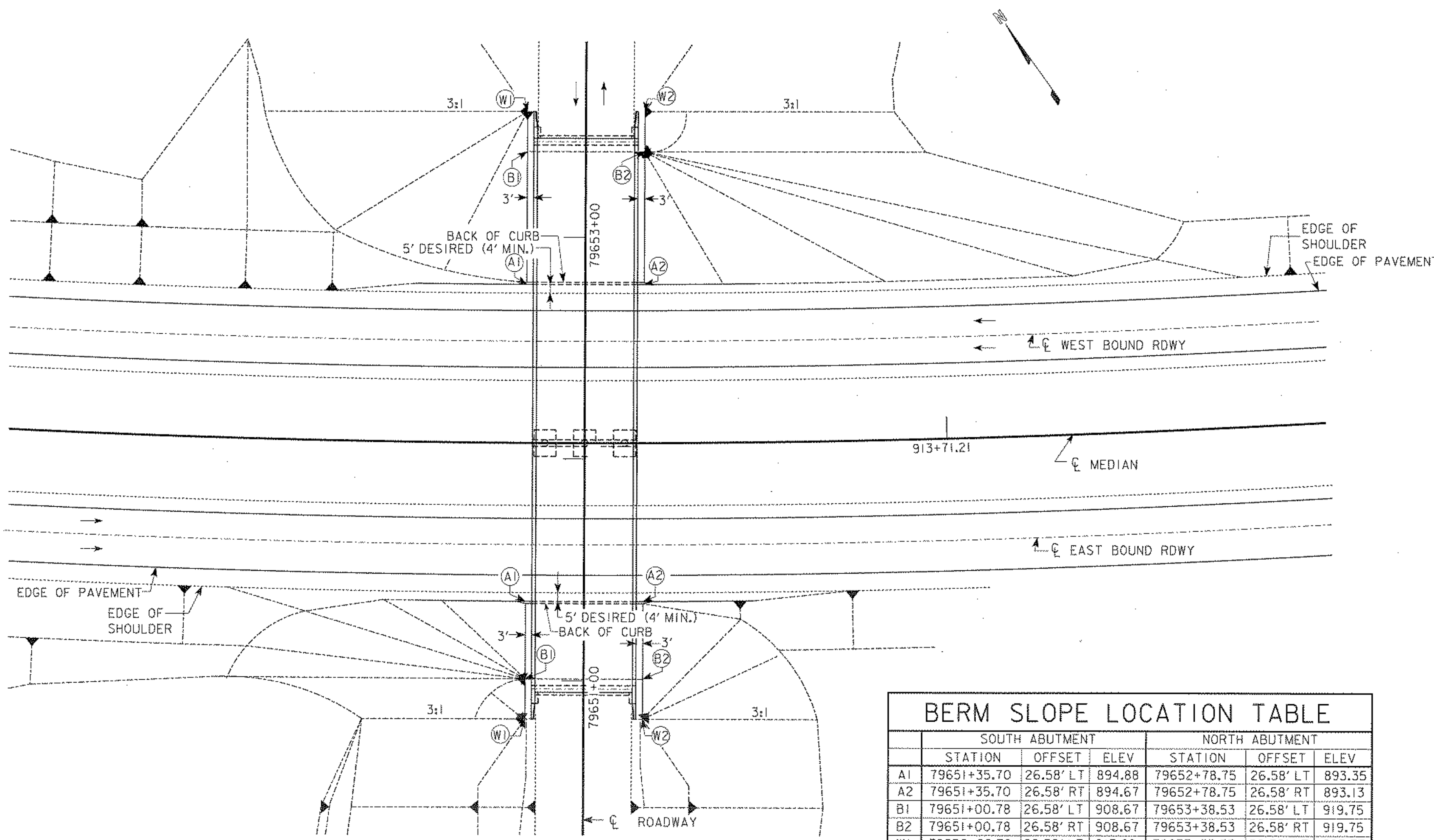
C3.2.7.3 Berms

C3.2.7.3.1 Slope

C3.2.7.3.2 Toe offset

C3.2.7.3.3 Berm slope location table

See also the RBLT example C3.2.7.3.4.



BERM SLOPE LOCATION TABLE

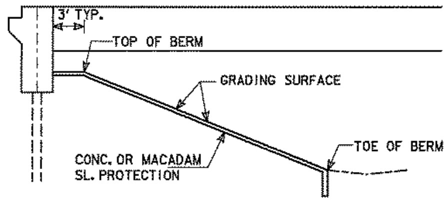
	SOUTH ABUTMENT			NORTH ABUTMENT		
	STATION	OFFSET	ELEV	STATION	OFFSET	ELEV
A1	79651+35.70	26.58' LT	894.88	79652+78.75	26.58' LT	893.35
A2	79651+35.70	26.58' RT	894.67	79652+78.75	26.58' RT	893.13
B1	79651+00.78	26.58' LT	908.67	79653+38.53	26.58' LT	919.75
B2	79651+00.78	26.58' RT	908.67	79653+38.53	26.58' RT	919.75
W1	79650+82.78	26.58' LT	915.22	79653+53.53	26.58' LT	927.37
W2	79650+82.78	26.58' RT	915.22	79653+53.53	26.58' RT	927.37

BERM SLOPE ELEVATIONS REFLECT GRADING SURFACE

EXAMPLE BERM SLOPE LOCATION TABLE (BSLT)

REVISED JULY 2013

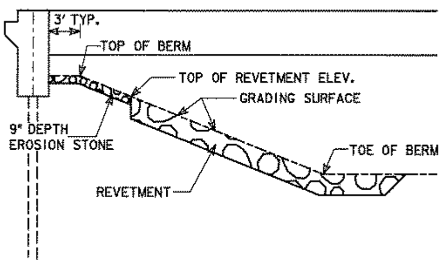
SLOPE PROTECTION LOCATION FOR BSLT GRADING SURFACES



NOTES:

1. BSLT POINTS GIVEN AT THE GRADING SURFACE = TOP OF SLOPE PROTECTION.
2. THE GRADING SURFACE IS DEFINED BY THE BRIDGE OFFICE SLOPE PROTECTION STANDARD.
3. WING ARMORING DETAILS ARE DEFINED BY THE BRIDGE OFFICE WING ARMORING STANDARDS.
4. SLOPE PROTECTION AND WING ARMORING QUANITIES WILL BE CALCULATED IN FINAL DESIGN.

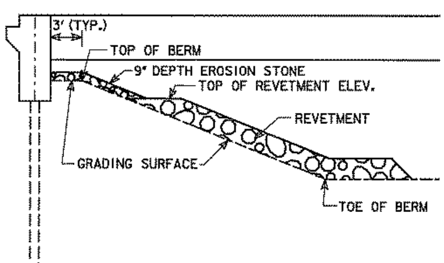
CONCETE OR MACADAM SLOPE PROTECTION



NOTES:

1. BSLT POINTS GIVEN AT GRADING SURFACE = TOP OF EROSION STONE AND TOP OF EMBEDDED REVETMENT.
2. THE GRADING SURFACE SHALL BE LABELED ON THE TSL REVETMENT TYPICAL SECTION. TOP OF REVETMENT ELEVATION SHALL BE DEFINED.
3. ADDITIONAL EROSION STONE DETAILS ARE COVERED BY THE BRIDGE OFFICE SLOPE PROTECTION STANDARD.
4. REVETMENT AND EROSION STONE BERM ARMORING ARE PLACED BELOW THE GRADING SURFACE AND WILL REQUIRE "CORE OUT". DEFINE LIMITS OF THE CORE OUT IN THE PLANS. THE BERM ARMORING QUANTITIES TABLE SHALL INCLUDE (AS APPLICABLE) CLASS 10 EXCAVATION, ENGINEERING FABRIC, EROSION STONE AND REVETMENT. BERM ARMORING GENERALLY INCLUDES QUANTITIES TO THE FACE OF THE ABUTMENT.
5. WING ARMORING DETAILS ARE DEFINED BY THE BRIDGE OFFICE WING ARMORING STANDARD. FINAL DESIGN WILL CALCULATE QUANTITIES RELATED TO THE WING ARMORING.

EMBEDDED REVETMENT

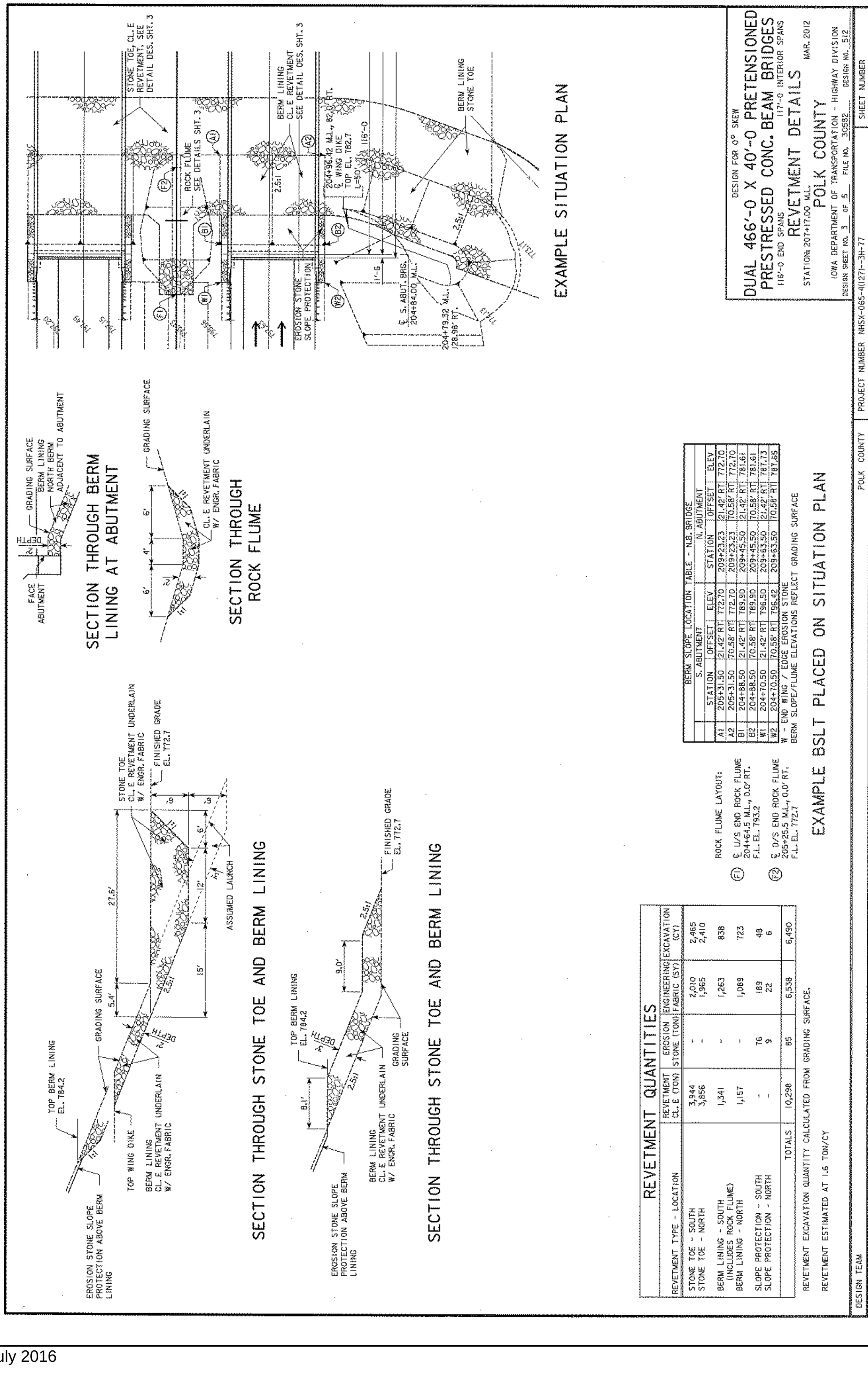


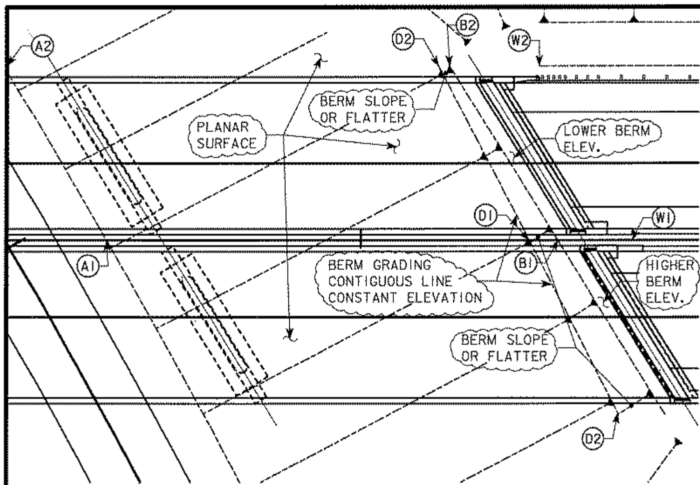
NOTES:

1. BSLT POINTS GIVEN AT GRADING SURFACE = BASE OF EROSION STONE AND BASE OF NON-EMBEDDED REVETMENT.
2. THE GRADING SURFACE SHALL BE LABELED ON THE TSL REVETMENT TYPICAL SECTION. TOP OF REVETMENT ELEVATION SHALL BE DEFINED.
3. ADDITIONAL EROSION STONE DETAILS ARE COVERED BY THE BRIDGE OFFICE SLOPE PROTECTION STANDARD.
4. THE BERM ARMORING QUANTITIES TABLE SHALL INCLUDE ENGINEERING FABRIC, EROSION STONE AND REVETMENT. BERM ARMORING QUANTITIES GENERALLY WILL INCLUDE ARMORING WORK UP TO THE FACE OF ABUTMENT.
5. WING ARMORING DETAILS ARE DEFINED BY THE BRIDGE OFFICE WING ARMORING STANDARD. FINAL DESIGN WILL CALCULATE QUANTITIES RELATED TO THE WING ARMORING.

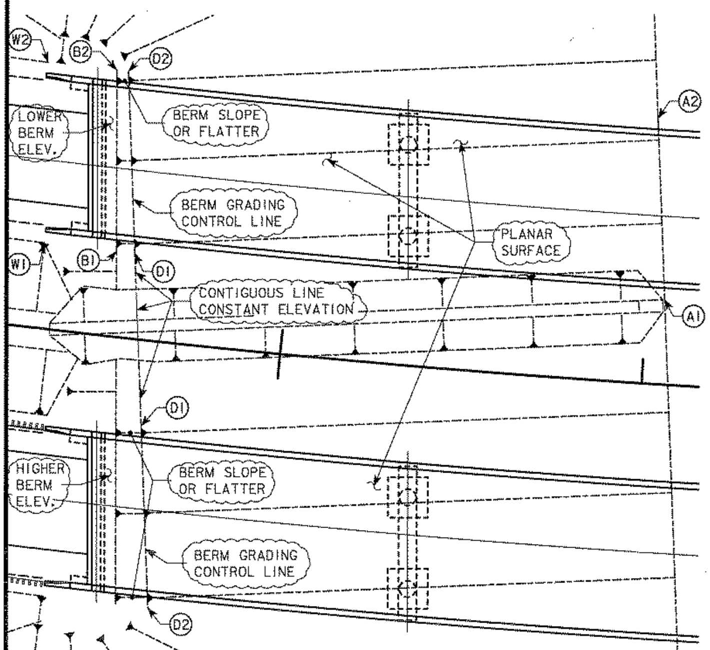
REVETMENT (NOT EMBEDDED)

4-24-12


EXAMPLE SITUATION PLAN
SECTION THROUGH BERM LINING AT ABUTMENT
SECTION THROUGH ROCK FLUME
SECTION THROUGH STONE TOE AND BERM LINING
SECTION THROUGH STONE TOE AND BERM LINING
EXAMPLE BSLT PLACED ON SITUATION PLAN
REVETMENT QUANTITIES
BERM SLOPE LOCATION TABLE - N.B. BRIDGE
ROCK FLUME LAYOUT:
DUAL 466'-0 X 40'-0 PRETENSIONED PRESTRESSED CONC. BEAM BRIDGES
REVETMENT DETAILS
POLK COUNTY
IOWA DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION



DUAL BRIDGES - MINIMAL SEPARATION



DUAL BRIDGES - TYPICAL SEPARATION

NOTES:

FOR DUAL BRIDGES A BERM GRADING CONTROL LINE WILL BE PROVIDED.

THE BERM GRADING CONTROL LINE IS A CONTIGUOUS LINE FROM 3 FT. BEYOND THE OUTSIDE BRIDGE FASCIA'S SET AT A CONSTANT ELEVATION. THE GRADING CONTROL LINE WILL RESULT IN A PLANAR BERM SURFACE BETWEEN AND UNDER THE BRIDGES.

FOR DUAL BRIDGES WHERE BOTH BERMS HAVE THE SAME ELEVATION AND THE EDGE OF THE 3 FT. BRIDGE BERM FORMS A CONTIGUOUS LINE OUT-OUT THE 'B' POINTS DEFINE THE BERM GRADING CONTROL LINE. FOR MOST DUAL BRIDGE SITES THIS CAN BE ACCOMPLISHED BY ADJUSTMENT OF THE LOW BRIDGE BERM AND/OR ELIMINATION OF A SLOPING BERM.

TO ATTAIN LEVEL/EQUAL BERM ELEVATIONS THE BERM CAN BE ELEVATED UP TO THE FOLLOWING LIMITS (ELEVATED FROM THE 2 FT. TYPICAL FROM BTM. FTG.):

INTEGRAL - 0.5 FT.
STUB - 0.75 FT.

THE PROVISIONS OF ARTICLE 3.2.7.2 (SLOPING OF ABUT. FOOTING/BERM) SHOULD BE REVIEWED FOR APPLICABILITY. THE PROVISIONS OF THE ABOVE ARTICLE SHALL GOVERN.

FOR SITES WHERE THE 'B' POINTS CANNOT BE ADJUSTED TO FORM A CONTIGUOUS LINE AT A CONSTANT ELEVATION, 'D' POINTS WILL BE UTILIZED TO DEFINE THE BERM GRADING CONTROL LINE.

THE CONTROL LINE WILL BE SET AT AN ELEVATION 1 FT. BELOW THE LOW BERM ELEVATION. THE ALIGNMENT WILL BE SET SUCH THAT THE SLOPE BETWEEN ADJACENT 'B' AND 'D' POINTS MATCHES OR IS FLATTER THAN THE BERM SLOPE BELOW THE GRADING CONTROL LINE.

BERM SLOPE LOCATION TABLE

POINTS	WEST ABUTMENT			EAST ABUTMENT		
	STATION	OFFSET	ELEV.	STATION	OFFSET	ELEV.
A1	891+04.80	23.40' LT	1200.80	895+34.10	23.40' LT	1200.80
A2	890+99.60	72.50' LT	1200.80	895+39.50	72.50' LT	1200.80
D1	889+57.40	23.40' LT	1249.28	896+70.50	23.40' LT	1245.70
D2	889+50.00	72.50' LT	1249.28	896+78.00	72.50' LT	1245.70
B1	889+52.25	23.40' LT	1250.28	896+76.00	23.40' LT	1246.70
B2	889+46.67	72.50' LT	1250.28	896+81.58	72.50' LT	1246.70
W1	889+32.20	23.40' LT	1257.74	896+96.05	23.40' LT	1254.17
W2	889+27.25	72.50' LT	1257.84	897+01.00	72.50' LT	1254.27

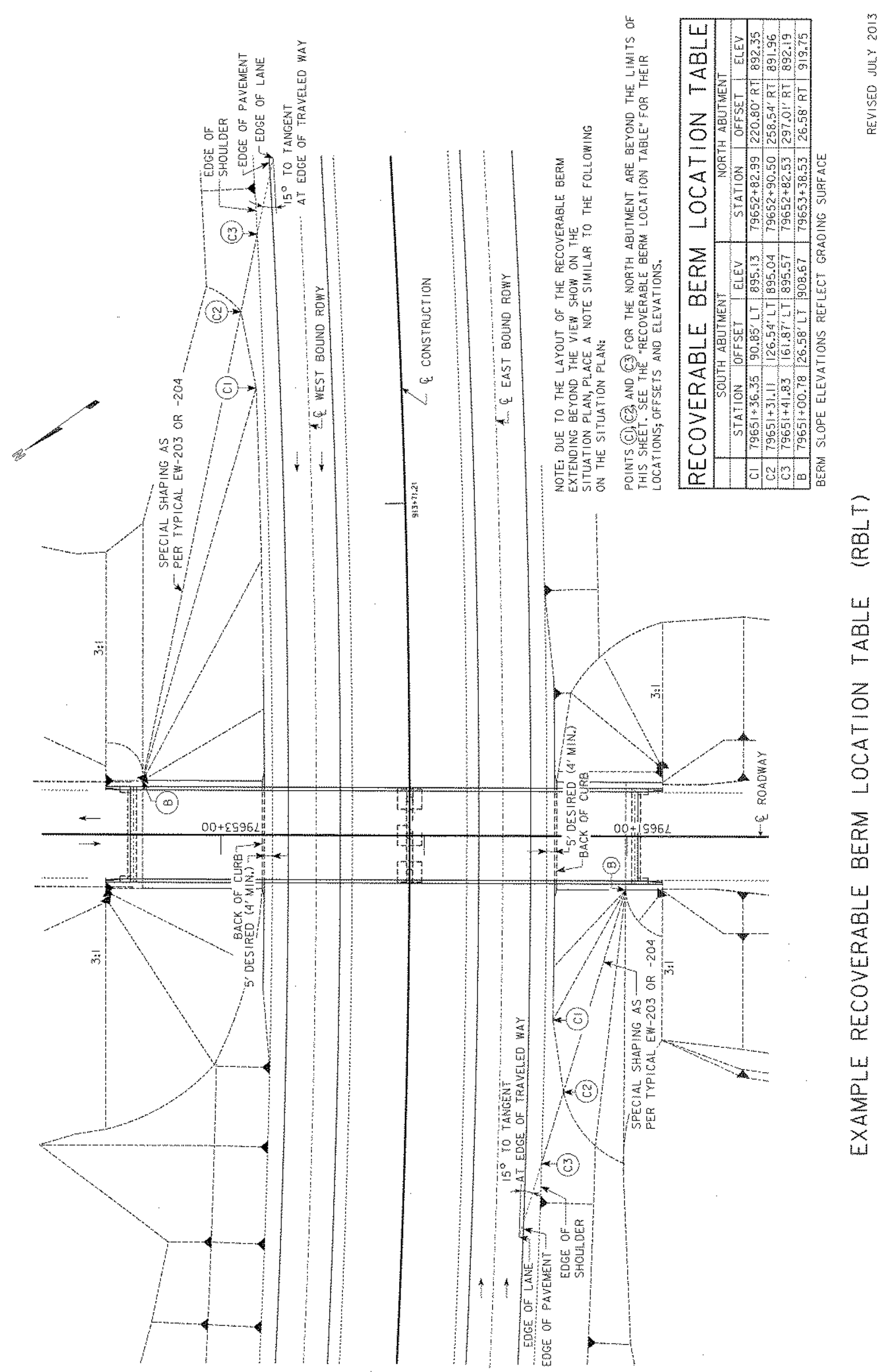
BERM SLOPE ELEVATIONS REFLECT THE GRADING SURFACE. BERM GRADING BELOW BERM GRADING CONTROL LINE DEFINED BY CONTROL LINE.
BERM GRADING CONTROL LINE IS DEFINED BY 'D' POINTS IN ABOVE TABLE.
[ALTERNATE NOTE FOR ABOVE WHEN 'D' POINTS NOT REQUIRED - SEE NOTES]
BERM GRADING CONTROL LINE IS DEFINED BY 'B' POINTS IN ABOVE TABLE.

DUAL BRIDGES
BERM SLOPE DEFINITION

REV. DATE: 5-01-13

C3.2.7.3.4 Recoverable berm location table

See also the BSLT example in C3.2.7.3.3.



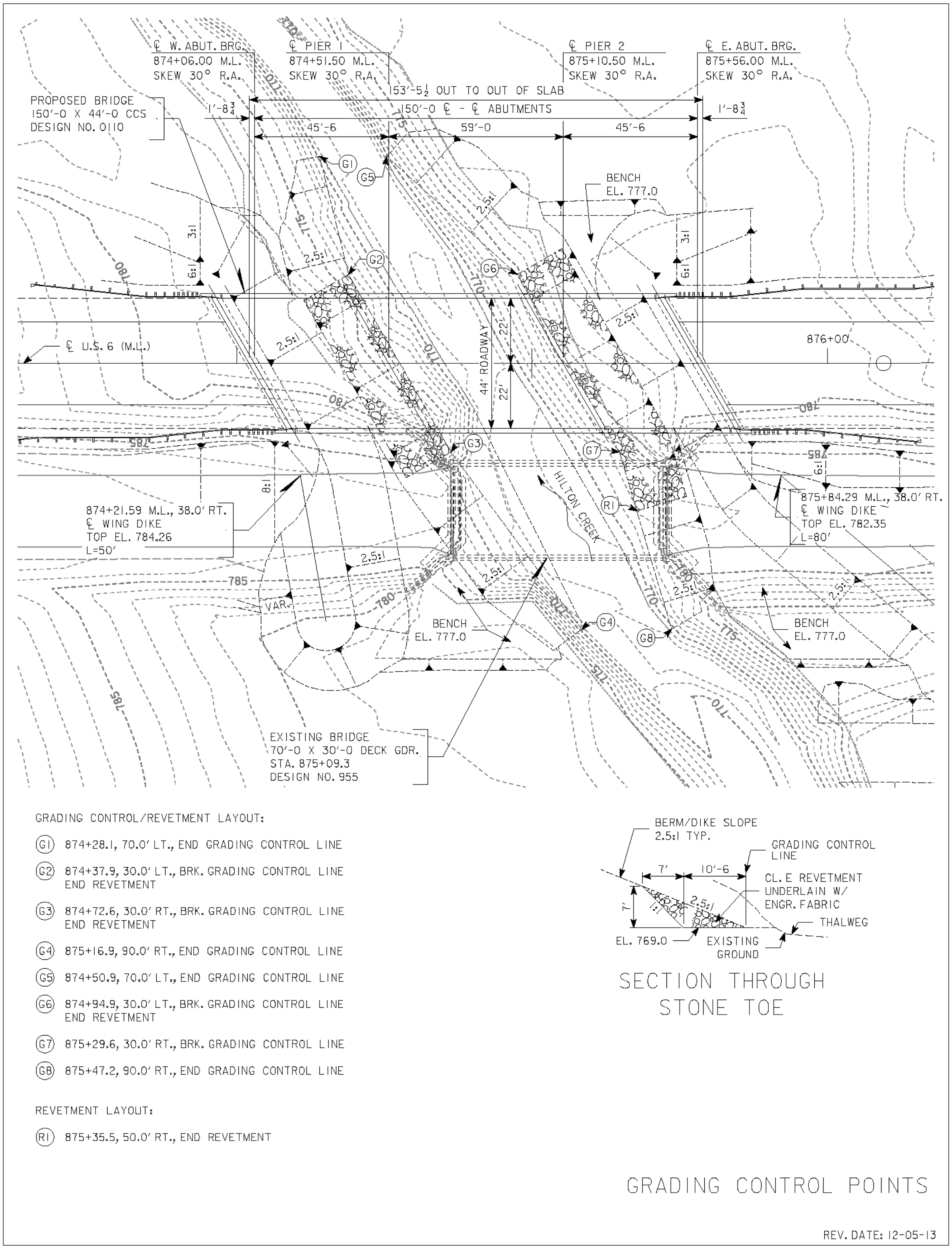
RECOVERABLE BERM LOCATION TABLE

	SOUTH ABUTMENT			NORTH ABUTMENT		
	STATION	OFFSET	ELEV	STATION	OFFSET	ELEV
C1	79651+36.35	90.85' LT	895.13	79652+82.99	220.80' RT	892.35
C2	79651+31.11	126.54' LT	895.04	79652+90.50	258.54' RT	891.96
C3	79651+41.83	161.87' LT	895.57	79652+82.53	297.01' RT	892.19
B	79651+00.78	26.58' LT	908.67	79653+38.53	26.58' RT	919.75

EXAMPLE RECOVERABLE BERM LOCATION TABLE (RBLT)

C3.2.7.3.5 Slope protection

C3.2.7.3.6 Grading Control Points



C3.2.7.4 Piers and pier footings

Ref: 2013 AASHTO LRFD Intermediate Revisions

cases where substructures are found to be inadequate to resist the increased longitudinal forces, consideration should be given to design and detailing strategies which distribute the braking force to additional substructure units during a braking event.

3.6.5—Vehicular Collision Force: *CT*

3.6.5.1—Protection of Structures

Unless the Owner determines that site conditions indicate otherwise, abutments and piers located within a distance of 30.0 ft to the edge of roadway shall be investigated for collision. Collision shall be addressed by either providing structural resistance or by redirecting or absorbing the collision load. The provisions of Article 2.3.2.2.1 shall apply as appropriate.

Where the design choice is to provide structural resistance, the pier or abutment shall be designed for an equivalent static force of 600 kip, which is assumed to act in a direction of zero to 15 degrees with the edge of the pavement in a horizontal plane, at a distance of 5.0 ft above ground.

Where the design choice is to redirect or absorb the collision load, protection shall consist of one of the following:

- An embankment;
- A structurally independent, crashworthy ground-mounted 54.0-in. high barrier, located within 10.0 ft from the component being protected; or
- A 42.0-in. high barrier located at more than 10.0 ft from the component being protected.

Such barrier shall be structurally and geometrically capable of surviving the crash test for Test Level 5, as specified in Section 13.

C3.6.5.1

Where an Owner chooses to make an assessment of site conditions for the purpose of implementing this provision, input from highway or safety engineers and structural engineers should be part of that assessment.

The equivalent static force of 600 kip is based on the information from full-scale crash tests of rigid columns impacted by 80.0-kip tractor trailers at 50 mph. For individual column shafts, the 600-kip load should be considered a point load. Field observations indicate shear failures are the primary mode of failure for individual columns and columns that are 30.0 in. in diameter and smaller are the most vulnerable. For wall piers, the load may be considered to be a point load or may be distributed over and area deemed suitable for the size of the structure and the anticipated impacting vehicle, but not greater than 5.0 ft wide by 2.0 ft high. These dimensions were determined by considering the size of a truck frame.

Requirements for train collision load found in previous editions have been removed. Designers are encouraged to consult the AREMA Manual for Railway Engineering or local railroad company guidelines for train collision requirements.

For the purpose of this Article, a barrier may be considered structurally independent if it does not transmit loads to the bridge.

Full-scale crash tests have shown that some vehicles have a greater tendency to lean over or partially cross over a 42.0-in. high barrier than a 54.0-in. high barrier. This behavior would allow a significant collision of the vehicle with the component being protected if the component is located within a few ft of the barrier. If the component is more than about 10.0 ft behind the barrier, the difference between the two barrier heights is no longer important.

One way to determine whether site conditions qualify for exemption from protection is to evaluate the annual frequency of impact from heavy vehicles. With the approval of the Owner, the annual frequency for a bridge pier to be hit by a heavy vehicle, AF_{HPB}, can be calculated by:

$$AF_{HBP} = 2(\text{ADTT})\,(P_{HBP})365 \qquad \text{(C3.6.5.1-1)}$$

where:

ADTT = the number of trucks per day in one direction

P_{HBP} = the annual probability for a bridge pier to be hit by a heavy vehicle

REF AASHTO LRFD 2013
INTERMEDIATE REVISIONS

Table C3.6.1.4.2-1 may be used to determine ADTT from available ADT data.

P_{HBP} = 3.457 x 10^{-9} for undivided roadways in tangent and horizontally curved sections

1.090 x 10^{-9} for divided roadways in tangent sections
2.184 x 10^{-9} for divided roadways in horizontally curved sections

Design for vehicular collision force is not required if AF_{HBP} is less than 0.0001 for critical or essential bridges or 0.001 for typical bridges.

The determination of the annual frequency for a bridge pier to be hit by a heavy vehicle, AF_{HPB}, is derived from limited statistical studies performed by the Texas Transportation Institute. Due to limited data, no distinction has been made between tangent sections and horizontally curved sections for undivided roadways. The target values for AF_{HBP} mirror those for vessel collision force found in Article 3.14.5.

Table C3.6.5.1-1 provides typical resulting values for AF_{HBP}.

Table C3.6.5.1-1—Typical Values of AF_{HBP}

		Undivided	Divided Curved	Divided Tangent
ADT (Both Directions)	ADTT* (One Way)	P_{HBP}=3.457E-09	P_{HBP}=2.184E-09	P_{HBP}=1.09E-09
		$AF_{HPB} = 2 \times \text{ADTT} \times 365 \times P_{HBP}$		
1000	50	0.0001	0.0001	0.0000
2000	100	0.0003	0.0002	0.0001
3000	150	0.0004	0.0002	0.0001
4000	200	0.0005	0.0003	0.0002
6000	300	0.0008	0.0005	0.0002
8000	400	0.0010	0.0006	0.0003
12000	600	0.0015	0.0010	0.0005
14000	700	0.0018	0.0011	0.0006
16000	800	0.0020	0.0013	0.0006
18000	900	0.0023	0.0014	0.0007
20000	1000	0.0025	0.0016	0.0008
22000	1100	0.0028	0.0018	0.0009
24000	1200	0.0030	0.0019	0.0010
26000	1300	0.0033	0.0021	0.0010
28000	1400	0.0035	0.0022	0.0011

*Assumes ten percent of ADT is truck traffic.

3.6.5.2—Vehicle Collision with Barriers

The provisions of Section 13 shall apply.

C3.2.7.5 Wing Walls